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Grau en Enginyeria en Tecnologies Industrials

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Treball de Fi de Grau

Grau en Enginyeria en Tecnologies Industrials

Creasix: app de diseño y producción de juguetes mediante TUI e impresión 3D

ANEXO 1: Manual de Instrucciones
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ANEXO 3: Diseño Inicial del sistema de Interacción
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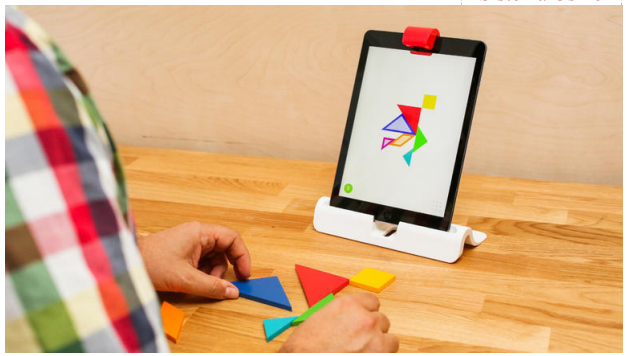
Anexo 1: Manual de instrucciones

Se ha realizado un manual básico de instrucciones para el uso de Creasix. Es un formato tríptico con algunas explicaciones y imágenes de la aplicación, así como el código QR que permite abrir el link del vídeo explicativo/promocional que se ha elaborado.

MANUAL DE INSTRUCCIONES

- **Creasix** es una aplicación de diseño de **juguetes personalizables** realizada para niños de 5 a 95 años. Su característica principal es la interacción física mediante objetos diseñados específicamente.
- La manipulación de **20 fichas** de juego y el **cubo Creasix** permite una completa personalización del juguete, lo que conduce a miles de potenciales divertidos diseños.
- Es compatible con cualquier dispositivo **iPad** y requiere el uso del sistema **Osmo** de *TangiblePlay*[1].

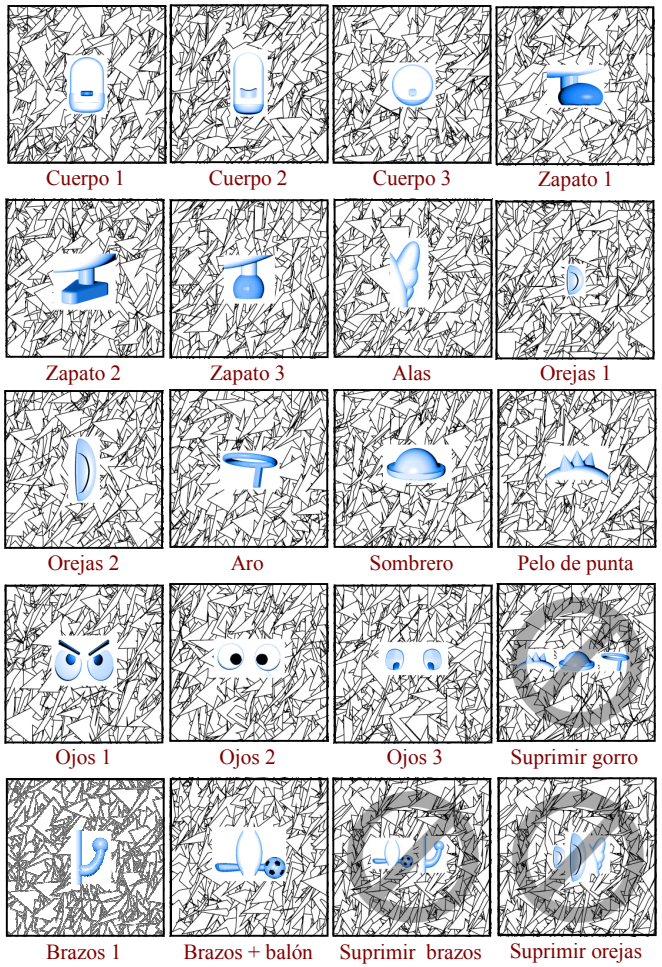


Sistema Osmo

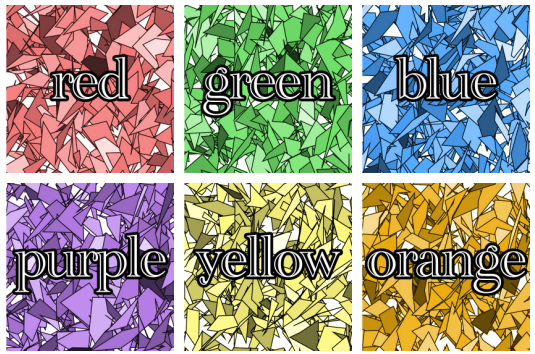
ES ASÍ DE FÁCIL

1. Selecciona un **color** con el Cubo Creasix
2. Introduce la **ficha** de la parte del cuerpo que elijas. Será del color seleccionado.
3. Si quieres, cambia otra vez el **color** una vez esté recién añadida.

FICHAS DE JUEGO



CUBO CREASIX



Anexo 2: Código de la aplicación

Para el desarrollo informático de la aplicación, se ha programado en lenguaje C# mediante el programa MonoDevelop, proporcionado por Unity3D para programar. Más allá de los archivos generados por la propia librería Vuforia y Unity3D para permitir el funcionamiento del *software* en iOS, han sido tres los *scripts*, que se han generado por elaboración propia. El más importante es `CustomEventHandler.cs` (Página 1), donde se realizan todas las acciones relacionadas con la interfaz *TUI* (detección de *markers* y todo lo que esto implica). Por lo que se refiere a la interfaz gráfica, los botones se han incorporado en un script llamado `GUIBasics.cs` (Página 24). Por último, para almacenar las variables de manera global de los dos anteriores scripts, se ha creado uno llamado `GlobalVar.cs` (Página 27).

`Script CustomEventHandler.cs`

```
using UnityEngine;
using System.Collections;

public class CustomEventHandler : MonoBehaviour,
                                  ITrackableEventHandler
{
  #region PRIVATE_MEMBER_VARIABLES

  private TrackableBehaviour mTrackableBehaviour;
  private GameObject PartSelected;
  private GameObject Body1;
  private GameObject Body2;
  private GameObject Body3a;
  private GameObject Body3b;
  private GameObject Body3c;
  private GameObject Body3d;
  private GameObject Body3e;
  private GameObject Jeans1;
  private GameObject Jeans2;
  private GameObject Jeans3;
  private GameObject Eyes1a;
  private GameObject Eyes1b;
  private GameObject Eyes2a;
  private GameObject Eyes2b;
```

```
private GameObject Eyes3a;
private GameObject Eyes3b;
private GameObject Leg1a;
private GameObject Leg1b;
private GameObject Leg2a;
private GameObject Leg2b;
private GameObject Leg3a;
private GameObject Leg3b;
private GameObject Foot1a;
private GameObject Foot1b;
private GameObject Foot2a;
private GameObject Foot2b;
private GameObject Foot3a;
private GameObject Foot3b;
private GameObject Hair1a;
private GameObject Hair1b;
private GameObject Hair1c;
private GameObject Hair2;
private GameObject Hair3;
private GameObject Ear1a;
private GameObject Ear1b;
private GameObject Ear2a;
private GameObject Ear2b;
private GameObject Ear3a;
private GameObject Ear3b;
private GameObject Arm1a;
private GameObject Arm1b;
private GameObject Hand1a;
private GameObject Hand1b;
private GameObject Arm2a;
private GameObject Arm2b;
private GameObject Ball2;
private GameObject Mouth3;

private GUIText descripcion;
private Terrain Terreno;
private GameObject[] parts;
private Material[] mats;
private Material MaterialSelected;
```

```
    private Material BlueMat;
    private Material YellowMat;
    private Material RedMat;
    private Material GreenMat;
    private Material PurpleMat;
    private Material OrangeMat;
    //private AudioSource[] audioSource;

    private Animator animator;

    #endregion // PRIVATE_MEMBER_VARIABLES

    #region UNTIY_MONOBEHAVIOUR_METHODS

    void Start()
    {
      //Definición todos los elementos de la escena
      Terreno = Terrain.activeTerrain;
      //audioSource = Terreno.GetComponents<AudioSource> ();
      descripcion = GUIText.FindObjectOfType<GUIText> ();
      Body1=GameObject.Find ("Body1");
      Body2=GameObject.Find ("Body2");
      Body3a=GameObject.Find ("Body3_MeshPart0");
      Body3b=GameObject.Find ("Body3_MeshPart1");
      Body3c=GameObject.Find ("Body3_MeshPart2");
      Body3d=GameObject.Find ("Body3_MeshPart3");
      Body3e=GameObject.Find ("Body3_MeshPart4");
      Jeans1=GameObject.Find ("Jeans1");
      Jeans2=GameObject.Find ("Jeans2");
      Jeans3=GameObject.Find ("Jeans3");
      Eyes1a=GameObject.Find ("Eyes1a");
      Eyes1b=GameObject.Find ("Eyes1b");
      Eyes2a=GameObject.Find ("Eyes2a");
      Eyes2b=GameObject.Find ("Eyes2b");
      Eyes3a=GameObject.Find ("Eyes3a");
      Eyes3b=GameObject.Find ("Eyes3b");
      Leg1a=GameObject.Find ("Leg1a");
      Leg1b=GameObject.Find ("Leg1b");
      Leg2a=GameObject.Find ("Leg2a");
```

```
Leg2b=GameObject.Find ("Leg2b");
Leg3a=GameObject.Find ("Leg3a");
Leg3b=GameObject.Find ("Leg3b");
Foot1a=GameObject.Find ("Foot1a");
Foot1b=GameObject.Find ("Foot1b");
Foot2a=GameObject.Find ("Foot2a");
Foot2b=GameObject.Find ("Foot2b");
Foot3a=GameObject.Find ("Foot3a");
Foot3b=GameObject.Find ("Foot3b");
Hair1a=GameObject.Find ("Hair1a");
Hair1b=GameObject.Find ("Hair1b");
Hair1c=GameObject.Find ("Hair1c");
Hair2=GameObject.Find ("Hair2");
Hair3=GameObject.Find ("Hair3");
Ear1a=GameObject.Find ("Ear1a");
Ear1b=GameObject.Find ("Ear1b");
Ear2a=GameObject.Find ("Ear2a");
Ear2b=GameObject.Find ("Ear2b");
Ear3a=GameObject.Find ("Ear3a");
Ear3b=GameObject.Find ("Ear3b");
Arm1a=GameObject.Find ("Arm1a");
Arm1b=GameObject.Find ("Arm1b");
Hand1a=GameObject.Find ("Hand1a");
Hand1b=GameObject.Find ("Hand1b");
Arm2a=GameObject.Find ("Arm2a");
Arm2b=GameObject.Find ("Arm2b");
Ball2=GameObject.Find ("Ball2");
Mouth3=GameObject.Find ("Mouth3");

//Posiciona todos los módulos en la posición que corresponde a Body1 (Tronco1)
Hair1a.transform.localPosition = new Vector3 (0, 67, 9);
Hair1b.transform.localPosition = new Vector3 (0, 69, 0);
Hair1c.transform.localPosition = new Vector3 (0, 67, -9);
Leg1a.transform.localPosition = new Vector3 (-7, -1, 0);
Leg1b.transform.localPosition = new Vector3 (7, -1, 0);
Foot1a.transform.localPosition = new Vector3 (-10, -4, 0);
Foot1b.transform.localPosition = new Vector3 (10, -4, 0);
Ear1a.transform.localPosition = new Vector3 (-17, 47, -2);
Ear1b.transform.localPosition = new Vector3 (17, 47, -2);
```

```
Eyes1a.transform.localPosition = new Vector3 (-6, 53, 28);
Eyes1b.transform.localPosition = new Vector3 (6, 53, 28);
Hair2.transform.localPosition = new Vector3 (0, 44, 0);
Leg2a.transform.localPosition = new Vector3 (-8, -15, 0);
Leg2b.transform.localPosition = new Vector3 (8, -15, 0);
Foot2a.transform.localPosition = new Vector3 (-8, -18, 3);
Foot2b.transform.localPosition = new Vector3 (8, -18, 3);
Arm1a.transform.localPosition = new Vector3 (-21, 25, 0);
Arm1b.transform.localPosition = new Vector3 (21, 25, 0);
Hand1a.transform.localPosition = new Vector3 (-29, 26, 0);
Hand1b.transform.localPosition = new Vector3 (29, 26, 0);
Ear2a.transform.localPosition = new Vector3 (-17, 28, 0);
Ear2b.transform.localPosition = new Vector3 (17, 28, 0);
Eyes2a.transform.localPosition = new Vector3 (-7, 27, 13);
Eyes2b.transform.localPosition = new Vector3 (7, 27, 13);
Hair3.transform.localPosition = new Vector3 (0, 44, 0);
Leg3a.transform.localPosition = new Vector3 (-8, -17, 5);
Leg3b.transform.localPosition = new Vector3 (8, -17, 5);
Foot3a.transform.localPosition = new Vector3 (-8, -36, 0);
Foot3b.transform.localPosition = new Vector3 (8, -36, 0);
Arm2a.transform.localPosition = new Vector3 (9, 8, 0);
Arm2b.transform.localPosition = new Vector3 (-9, 8, 0);
Ball2.transform.localPosition = new Vector3 (-35, 1, -4);
Ear3a.transform.localPosition = new Vector3 (-17, 6, 0);
Ear3b.transform.localPosition = new Vector3 (17, 6, 0);
Eyes3a.transform.localPosition = new Vector3 (3, 3, -6);
Eyes3b.transform.localPosition = new Vector3 (-3, 3, -6);

//Oculta los Cuerpos 2 y 3 y todos sus módulos iniciales
Body2.renderer.enabled = false;
Jeans2.renderer.enabled = false;
Eyes2a.renderer.enabled = false;
Eyes2b.renderer.enabled = false;
Leg2a.renderer.enabled = false;
Leg2b.renderer.enabled = false;
Foot2a.renderer.enabled = false;
Foot2b.renderer.enabled = false;
Hair2.renderer.enabled = false;
Ear2a.renderer.enabled = false;
```

```
Ear2b.renderer.enabled = false;
Arm1a.renderer.enabled = false;
Arm1b.renderer.enabled = false;
Hand1a.renderer.enabled = false;
Hand1b.renderer.enabled = false;
Body3a.renderer.enabled = false;
Body3b.renderer.enabled = false;
Body3c.renderer.enabled = false;
Body3d.renderer.enabled = false;
Body3e.renderer.enabled = false;
Jeans3.renderer.enabled = false;
Eyes3a.renderer.enabled = false;
Eyes3b.renderer.enabled = false;
Leg3a.renderer.enabled = false;
Leg3b.renderer.enabled = false;
Foot3a.renderer.enabled = false;
Foot3b.renderer.enabled = false;
Hair3.renderer.enabled = false;
Ear3a.renderer.enabled = false;
Ear3b.renderer.enabled = false;
Arm2a.renderer.enabled = false;
Arm2b.renderer.enabled = false;
Ball2.renderer.enabled = false;
Mouth3.renderer.enabled = false;

//Carga los 6 Colores
BlueMat = Resources.Load("ColorBlue", typeof(Material)) as Material;
GreenMat = Resources.Load("ColorGreen", typeof(Material)) as Material;
OrangeMat = Resources.Load("ColorOrange", typeof(Material)) as Material;
PurpleMat = Resources.Load("ColorPurple", typeof(Material)) as Material;
RedMat = Resources.Load("ColorRed", typeof(Material)) as Material;
YellowMat = Resources.Load("ColorYellow", typeof(Material)) as Material;

//Empieza seleccionando el Body1 y el color Azul
GlobalVar.nPartSelected = 1;
GlobalVar.MatSelected = BlueMat;


mTrackableBehaviour = GetComponent<TrackableBehaviour>();
```

```
    if (mTrackableBehaviour)
    {
      mTrackableBehaviour.RegisterTrackableEventHandler(this);
    }

    OnTrackingLost();

  }

  void Update()
  {

    }

  #endregion // UNTIY_MONOBEHAVIOUR_METHODS

  #region PUBLIC_METHODS

  /// <summary>
  /// Implementation of the ITrackableEventHandler function called when the
  /// tracking state changes.
  /// </summary>
  public void OnTrackableStateChanged(
                          TrackableBehaviour.Status previousStatus,
                          TrackableBehaviour.Status newStatus)
  {
    if (newStatus == TrackableBehaviour.Status.DETECTED ||
      newStatus == TrackableBehaviour.Status.TRACKED ||
      newStatus == TrackableBehaviour.Status.EXTENDED_TRACKED)
    {
      OnTrackingFound();
    }
    else
    {
      OnTrackingLost();
    }
  }

  #endregion // PUBLIC_METHODS
```

```
#region PRIVATE_METHODS


private void OnTrackingFound()
{
    //Marcador Encontrado
    Renderer[] rendererComponents = GetComponentsInChildren<Renderer> (true);
    Collider[] colliderComponents = GetComponentsInChildren<Collider> (true);

    // Enable rendering:
    foreach (Renderer component in rendererComponents) {
        component.enabled = true;
    }

    // Enable colliders:
    foreach (Collider component in colliderComponents) {
        component.enabled = true;
    }

    Debug.Log ("Trackable " + mTrackableBehaviour.TrackableName + " found");

    bool esColor = false;

    //Comprueba si el marcador encontrado es algun color
    if (mTrackableBehaviour.TrackableName == "BlueColor") {
        esColor = true;
        GlobalVar.MatSelected = BlueMat;
        //    audioSource [1].Play ();
    } else if (mTrackableBehaviour.TrackableName == "GreenColor") {
        esColor = true;
        GlobalVar.MatSelected = GreenMat;
        //    audioSource [1].Play ();
    } else if (mTrackableBehaviour.TrackableName == "OrangeColor") {
        esColor = true;;
        GlobalVar.MatSelected = OrangeMat;
        //    audioSource [1].Play ();
    } else if (mTrackableBehaviour.TrackableName == "PurpleColor") {
```

```
            esColor = true;
            GlobalVar.MatSelected = PurpleMat;
            //   audioSource [1].Play ();
        } else if (mTrackableBehaviour.TrackableName == "RedColor") {
            esColor = true;
            GlobalVar.MatSelected = RedMat;
            //   audioSource [1].Play ();
        } else if (mTrackableBehaviour.TrackableName == "YellowColor") {
            esColor = true;
            GlobalVar.MatSelected = YellowMat;
            //   audioSource [1].Play ();
        } else {
            //audioSource [2].Play ();
        }

        MaterialSelected = GlobalVar.MatSelected;
        Terreno.materialTemplate = MaterialSelected;

    //Comprueba si el marcador encontrado es uno de los módulos
            if (mTrackableBehaviour.TrackableName == "FichaBody1") {
                GlobalVar.nPartSelected = 1;
                parts = new GameObject[2];
                parts [0] = Body1;
                parts [1] = Jeans1;
                for (int i=0; i<parts.Length; i++) {
                    parts [i].renderer.enabled = true;
                }
                Body2.renderer.enabled = false;
                Body3a.renderer.enabled = false;
                Body3b.renderer.enabled = false;
                Body3c.renderer.enabled = false;
                Body3d.renderer.enabled = false;
                Body3e.renderer.enabled = false;
                Mouth3.renderer.enabled = false;
                Jeans2.renderer.enabled = false;
                Jeans3.renderer.enabled = false;
                descripcion.text = "Tronco Seleccionado";

                //Reposiciona módulos
```

```
        Hair1a.transform.localPosition = new Vector3 (0, 67, 9);
        Hair1b.transform.localPosition = new Vector3 (0, 69, 0);
        Hair1c.transform.localPosition = new Vector3 (0, 67, -9);
        Leg1a.transform.localPosition = new Vector3 (-7, -1, 0);
        Leg1b.transform.localPosition = new Vector3 (7, -1, 0);
        Foot1a.transform.localPosition = new Vector3 (-10, -4, 0);
        Foot1b.transform.localPosition = new Vector3 (10, -4, 0);
        Ear1a.transform.localPosition = new Vector3 (-17, 47, -2);
        Ear1b.transform.localPosition = new Vector3 (17, 47, -2);
        Eyes1a.transform.localPosition = new Vector3 (-6, 53, 28);
        Eyes1b.transform.localPosition = new Vector3 (6, 53, 28);
        Hair2.transform.localPosition = new Vector3 (0, 44, 0);
        Leg2a.transform.localPosition = new Vector3 (-8, -15, 0);
        Leg2b.transform.localPosition = new Vector3 (8, -15, 0);
        Foot2a.transform.localPosition = new Vector3 (-8, -18, 3);
        Foot2b.transform.localPosition = new Vector3 (8, -18, 3);
        Arm1a.transform.localPosition = new Vector3 (-21, 25, 0);
        Arm1b.transform.localPosition = new Vector3 (21, 25, 0);
        Hand1a.transform.localPosition = new Vector3 (-29, 26, 0);
        Hand1b.transform.localPosition = new Vector3 (29, 26, 0);
        Ear2a.transform.localPosition = new Vector3 (-17, 28, 0);
        Ear2b.transform.localPosition = new Vector3 (17, 28, 0);
        Eyes2a.transform.localPosition = new Vector3 (-7, 27, 13);
        Eyes2b.transform.localPosition = new Vector3 (7, 27, 13);
        Hair3.transform.localPosition = new Vector3 (0, 44, 0);
        Leg3a.transform.localPosition = new Vector3 (-8, -17, 5);
        Leg3b.transform.localPosition = new Vector3 (8, -17, 5);
        Foot3a.transform.localPosition = new Vector3 (-8, -36, 0);
        Foot3b.transform.localPosition = new Vector3 (8, -36, 0);
        Arm2a.transform.localPosition = new Vector3 (9, 8, 0);
        Arm2b.transform.localPosition = new Vector3 (-9, 8, 0);
        Ball2.transform.localPosition = new Vector3 (-35, 1, -4);
        Ear3a.transform.localPosition = new Vector3 (-17, 6, 0);
        Ear3b.transform.localPosition = new Vector3 (17, 6, 0);
        Eyes3a.transform.localPosition = new Vector3 (3, 3, -6);
        Eyes3b.transform.localPosition = new Vector3 (-3, 3, -6);

    }
    if (mTrackableBehaviour.TrackableName == "FichaBody2") {
```

```
GlobalVar.nPartSelected = 2;
parts = new GameObject[2];
parts [0] = Body2;
parts [1] = Jeans2;
for (int i=0; i<parts.Length; i++) {
      parts [i].renderer.enabled = true;
}
Body1.renderer.enabled = false;
Body3a.renderer.enabled = false;
Body3b.renderer.enabled = false;
Body3c.renderer.enabled = false;
Body3d.renderer.enabled = false;
Body3e.renderer.enabled = false;
Mouth3.renderer.enabled = false;
Jeans1.renderer.enabled = false;
Jeans3.renderer.enabled = false;
descripcion.text = "Tronco Seleccionado";

//Reposiciona módulos
Hair1a.transform.localPosition = new Vector3 (0, 0, 0);
Hair1a.transform.localPosition = new Vector3 (0, 75, 9);
Hair1b.transform.localPosition = new Vector3 (0, 77, 0);
Hair1c.transform.localPosition = new Vector3 (0, 75, -9);
Leg1a.transform.localPosition = new Vector3 (-7, -3, 0);
Leg1b.transform.localPosition = new Vector3 (7, -3, 0);
Foot1a.transform.localPosition = new Vector3 (-10, -6, 0);
Foot1b.transform.localPosition = new Vector3 (10, -6, 0);
Ear1a.transform.localPosition = new Vector3 (-17, 49, -2);
Ear1b.transform.localPosition = new Vector3 (17, 49, -2);
Eyes1a.transform.localPosition = new Vector3 (-6, 57, 28);
Eyes1b.transform.localPosition = new Vector3 (6, 57, 28);
Hair2.transform.localPosition = new Vector3 (0, 49, 0);
Leg2a.transform.localPosition = new Vector3 (-8, -17, 0);
Leg2b.transform.localPosition = new Vector3 (8, -17, 0);
Foot2a.transform.localPosition = new Vector3 (-8, -20, 3);
Foot2b.transform.localPosition = new Vector3 (8, -20, 3);
Arm1a.transform.localPosition = new Vector3 (-20, 31, 0);
Arm1b.transform.localPosition = new Vector3 (20, 31, 0);
Hand1a.transform.localPosition = new Vector3 (-28, 32, 0);
```

```
        Hand1b.transform.localPosition = new Vector3 (28, 32, 0);
        Ear2a.transform.localPosition = new Vector3 (-16, 34, 0);
        Ear2b.transform.localPosition = new Vector3 (16, 34, 0);
        Eyes2a.transform.localPosition = new Vector3 (-7, 33, 12);
        Eyes2b.transform.localPosition = new Vector3 (7, 33, 12);
        Hair3.transform.localPosition = new Vector3 (0, 50, 0);
        Leg3a.transform.localPosition = new Vector3 (-8, -17, 5);
        Leg3b.transform.localPosition = new Vector3 (8, -17, 5);
        Foot3a.transform.localPosition = new Vector3 (-8, -36, 0);
        Foot3b.transform.localPosition = new Vector3 (8, -36, 0);
        Arm2a.transform.localPosition = new Vector3 (11, 8, 0);
        Arm2b.transform.localPosition = new Vector3 (-11, 8, 0);
        Ball2.transform.localPosition = new Vector3 (-35, 1, -4);
        Ear3a.transform.localPosition = new Vector3 (-16, 14, 0);
        Ear3b.transform.localPosition = new Vector3 (16, 14, 0);
        Eyes3a.transform.localPosition = new Vector3 (3, 11, -7);
        Eyes3b.transform.localPosition = new Vector3 (-3, 11, -7);
    }
    if (mTrackableBehaviour.TrackableName == "FichaBody3") {
        GlobalVar.nPartSelected = 3;
        parts = new GameObject[6];
        parts [0] = Body3a;
        parts [1] = Body3b;
        parts [2] = Body3c;
        parts [3] = Body3d;
        parts [4] = Body3e;
        parts [5] = Jeans3;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Mouth3.renderer.enabled = true;
        Body2.renderer.enabled = false;
        Body1.renderer.enabled = false;
        Jeans2.renderer.enabled = false;
        Jeans1.renderer.enabled = false;
        descripcion.text = "Tronco Seleccionado";

        //Reposiciona módulos
        Hair1a.transform.localPosition = new Vector3 (0, 61, 9);
```

```
        Hair1b.transform.localPosition = new Vector3 (0, 63, 0);
        Hair1c.transform.localPosition = new Vector3 (0, 61, -9);
        Leg1a.transform.localPosition = new Vector3 (-7, -1, 0);
        Leg1b.transform.localPosition = new Vector3 (7, -1, 0);
        Foot1a.transform.localPosition = new Vector3 (-10, -4, 0);
        Foot1b.transform.localPosition = new Vector3 (10, -4, 0);
        Ear1a.transform.localPosition = new Vector3 (-27, 35, -2);
        Ear1b.transform.localPosition = new Vector3 (27, 35, -2);
        Eyes1a.transform.localPosition = new Vector3 (-10, 47, 37);
        Eyes1b.transform.localPosition = new Vector3 (10, 47, 37);
        Hair2.transform.localPosition = new Vector3 (0, 42, 0);
        Leg2a.transform.localPosition = new Vector3 (-8, -14, 0);
        Leg2b.transform.localPosition = new Vector3 (8, -14, 0);
        Foot2a.transform.localPosition = new Vector3 (-8, -17, 3);
        Foot2b.transform.localPosition = new Vector3 (8, -17, 3);
        Arm1a.transform.localPosition = new Vector3 (-26, 14, 0);
        Arm1b.transform.localPosition = new Vector3 (26, 14, 0);
        Hand1a.transform.localPosition = new Vector3 (-34, 15, 0);
        Hand1b.transform.localPosition = new Vector3 (34, 15, 0);
        Ear2a.transform.localPosition = new Vector3 (-26, 20, 0);
        Ear2b.transform.localPosition = new Vector3 (26, 20, 0);
        Eyes2a.transform.localPosition = new Vector3 (-7, 26, 21);
        Eyes2b.transform.localPosition = new Vector3 (7, 26, 21);
        Hair3.transform.localPosition = new Vector3 (0, 37, 0);
        Leg3a.transform.localPosition = new Vector3 (-8, -17, 5);
        Leg3b.transform.localPosition = new Vector3 (8, -17, 5);
        Foot3a.transform.localPosition = new Vector3 (-8, -36, 0);
        Foot3b.transform.localPosition = new Vector3 (8, -36, 0);
        Arm2a.transform.localPosition = new Vector3 (0, 0, 0);
        Arm2b.transform.localPosition = new Vector3 (0, 0, 0);
        Ball2.transform.localPosition = new Vector3 (-44, -7, -4);
        Ear3a.transform.localPosition = new Vector3 (-27, 6, 0);
        Ear3b.transform.localPosition = new Vector3 (27, 6, 0);
        Eyes3a.transform.localPosition = new Vector3 (0, 0, 0);
        Eyes3b.transform.localPosition = new Vector3 (0, 0, 0);
    }
    if (mTrackableBehaviour.TrackableName == "FichaEyes1") {
        GlobalVar.nPartSelected = 4;
        parts = new GameObject[2];
```

```
        parts [0] = Eyes1a;
        parts [1] = Eyes1b;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Eyes2a.renderer.enabled = false;
        Eyes2b.renderer.enabled = false;
        Eyes3a.renderer.enabled = false;
        Eyes3b.renderer.enabled = false;
        descripcion.text = "Ojos Seleccionados";
    }
    if (mTrackableBehaviour.TrackableName == "FichaEyes2") {
        GlobalVar.nPartSelected = 5;
        parts = new GameObject[2];
        parts [0] = Eyes2a;
        parts [1] = Eyes2b;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Eyes1a.renderer.enabled = false;
        Eyes1b.renderer.enabled = false;
        Eyes3a.renderer.enabled = false;
        Eyes3b.renderer.enabled = false;
        descripcion.text = "Ojos Seleccionados";
    }
    if (mTrackableBehaviour.TrackableName == "FichaEyes3") {
        GlobalVar.nPartSelected = 6;
        parts = new GameObject[2];
        parts [0] = Eyes3a;
        parts [1] = Eyes3b;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Eyes2a.renderer.enabled = false;
        Eyes2b.renderer.enabled = false;
        Eyes1a.renderer.enabled = false;
        Eyes1b.renderer.enabled = false;
        descripcion.text = "Ojos Seleccionados";
    }
```

```
if (mTrackableBehaviour.TrackableName == "FichaShoe1") {
    GlobalVar.nPartSelected = 7;
    parts = new GameObject[2];
    parts [0] = Foot1a;
    parts [1] = Foot1b;
    for (int i=0; i<parts.Length; i++) {
        parts [i].renderer.enabled = true;
    }
    Leg1a.renderer.enabled = true;
    Leg1b.renderer.enabled = true;
    Leg2a.renderer.enabled = false;
    Leg2b.renderer.enabled = false;
    Leg3a.renderer.enabled = false;
    Leg3b.renderer.enabled = false;
    Foot2a.renderer.enabled = false;
    Foot2b.renderer.enabled = false;
    Foot3a.renderer.enabled = false;
    Foot3b.renderer.enabled = false;
    descripcion.text = "Zapatos Seleccionados";
}
if (mTrackableBehaviour.TrackableName == "FichaShoe2") {
    GlobalVar.nPartSelected = 8;
    parts = new GameObject[2];
    parts [0] = Foot2a;
    parts [1] = Foot2b;
    for (int i=0; i<parts.Length; i++) {
        parts [i].renderer.enabled = true;
    }
    Leg2a.renderer.enabled = true;
    Leg2b.renderer.enabled = true;
    Leg1a.renderer.enabled = false;
    Leg1b.renderer.enabled = false;
    Leg3a.renderer.enabled = false;
    Leg3b.renderer.enabled = false;
    Foot1a.renderer.enabled = false;
    Foot1b.renderer.enabled = false;
    Foot3a.renderer.enabled = false;
    Foot3b.renderer.enabled = false;
    descripcion.text = "Zapatos Seleccionados";
```

```
}
if (mTrackableBehaviour.TrackableName == "FichaShoe3") {
    GlobalVar.nPartSelected = 9;
    parts = new GameObject[2];
    parts [0] = Foot3a;
    parts [1] = Foot3b;
    for (int i=0; i<parts.Length; i++) {
        parts [i].renderer.enabled = true;
    }
    Leg3a.renderer.enabled = true;
    Leg3b.renderer.enabled = true;
    Leg1a.renderer.enabled = false;
    Leg1b.renderer.enabled = false;
    Leg2a.renderer.enabled = false;
    Leg2b.renderer.enabled = false;
    Foot1a.renderer.enabled = false;
    Foot1b.renderer.enabled = false;
    Foot2a.renderer.enabled = false;
    Foot2b.renderer.enabled = false;
    descripcion.text = "Zapatos Seleccionados";
}
if (mTrackableBehaviour.TrackableName == "FichaHair1") {
    GlobalVar.nPartSelected = 10;
    parts = new GameObject[3];
    parts [0] = Hair1a;
    parts [1] = Hair1b;
    parts [2] = Hair1c;
    for (int i=0; i<parts.Length; i++) {
        parts [i].renderer.enabled = true;
    }
    Hair2.renderer.enabled = false;
    Hair3.renderer.enabled = false;
    descripcion.text = "Pelo Seleccionado";
}
if (mTrackableBehaviour.TrackableName == "FichaHair2") {
    GlobalVar.nPartSelected = 11;
    parts = new GameObject[1];
    parts [0] = GameObject.Find ("Hair2");
    for (int i=0; i<parts.Length; i++) {
```

```
            parts [i].renderer.enabled = true;
        }
        Hair1a.renderer.enabled = false;
        Hair1b.renderer.enabled = false;
        Hair1c.renderer.enabled = false;
        Hair3.renderer.enabled = false;
        descripcion.text = "Pelo Seleccionado";
    }
    if (mTrackableBehaviour.TrackableName == "FichaHair3") {
        GlobalVar.nPartSelected = 12;
        parts = new GameObject[1];
        parts [0] = Hair3;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Hair1a.renderer.enabled = false;
        Hair1b.renderer.enabled = false;
        Hair1c.renderer.enabled = false;
        Hair2.renderer.enabled = false;
        descripcion.text = "Pelo Seleccionado";
    }
    if (mTrackableBehaviour.TrackableName == "FichaHair0") {
        GlobalVar.nPartSelected = 13;
        parts = new GameObject[1];
        parts [0] = null;
        Hair1a.renderer.enabled = false;
        Hair1b.renderer.enabled = false;
        Hair1c.renderer.enabled = false;
        Hair2.renderer.enabled = false;
        descripcion.text = "Sin Seleccion";
    }
    if (mTrackableBehaviour.TrackableName == "FichaEar1") {
        GlobalVar.nPartSelected = 14;
        parts = new GameObject[2];
        parts [0] = Ear1a;
        parts [1] = Ear1b;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
```

```
        Ear2a.renderer.enabled = false;
        Ear2b.renderer.enabled = false;
        Ear3a.renderer.enabled = false;
        Ear3b.renderer.enabled = false;
        descripcion.text = "Orejas Seleccionadas";
    }
    if (mTrackableBehaviour.TrackableName == "FichaEar2") {
        GlobalVar.nPartSelected = 15;
        parts = new GameObject[2];
        parts [0] = Ear2a;
        parts [1] = Ear2b;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Ear1a.renderer.enabled = false;
        Ear1b.renderer.enabled = false;
        Ear3a.renderer.enabled = false;
        Ear3b.renderer.enabled = false;
        descripcion.text = "Orejas Seleccionadas";
    }
    if (mTrackableBehaviour.TrackableName == "FichaEar3") {
        GlobalVar.nPartSelected = 16;
        parts = new GameObject[2];
        parts [0] = Ear3a;
        parts [1] = Ear3b;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Ear1a.renderer.enabled = false;
        Ear1b.renderer.enabled = false;
        Ear2a.renderer.enabled = false;
        Ear2b.renderer.enabled = false;
        descripcion.text = "Orejas Seleccionadas";
    }
    if (mTrackableBehaviour.TrackableName == "FichaEar0") {
        GlobalVar.nPartSelected = 17;
        parts = new GameObject[1];
        parts [0] = null;
        Ear1a.renderer.enabled = false;
```

```
        Ear1b.renderer.enabled = false;
        Ear2a.renderer.enabled = false;
        Ear2b.renderer.enabled = false;
        Ear3a.renderer.enabled = false;
        Ear3b.renderer.enabled = false;
        descripcion.text = "Sin Seleccion";
    }
    if (mTrackableBehaviour.TrackableName == "FichaArms1") {
        GlobalVar.nPartSelected = 18;
        parts = new GameObject[4];
        parts [0] = Arm1a;
        parts [1] = Arm1b;
        parts [2] = Hand1a;
        parts [3] = Hand1b;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Arm2a.renderer.enabled = false;
        Arm2b.renderer.enabled = false;
        Ball2.renderer.enabled = false;
        descripcion.text = "Brazos Seleccionados";
    }
    if (mTrackableBehaviour.TrackableName == "FichaArms2") {
        GlobalVar.nPartSelected = 19;
        parts = new GameObject[3];
        parts [0] = Arm2a;
        parts [1] = Arm2b;
        parts [2] = Ball2;
        for (int i=0; i<parts.Length; i++) {
            parts [i].renderer.enabled = true;
        }
        Arm1a.renderer.enabled = false;
        Arm1b.renderer.enabled = false;
        Hand1a.renderer.enabled = false;
        Hand1b.renderer.enabled = false;
        descripcion.text = "Brazos Seleccionados";
    }
    if (mTrackableBehaviour.TrackableName == "FichaArms0") {
        GlobalVar.nPartSelected = 20;
```

```
                parts = new GameObject[1];
                parts [0] = null;
                Arm1a.renderer.enabled = false;
                Arm1b.renderer.enabled = false;
                Hand1a.renderer.enabled = false;
                Hand1b.renderer.enabled = false;
                Arm2a.renderer.enabled = false;
                Arm2b.renderer.enabled = false;
                Ball2.renderer.enabled = false;
                descripcion.text = "Sin Seleccion";
            }
    //Modificia el color del módulo seleccionado
    switch (GlobalVar.nPartSelected) {
        case 1:
            mats = Body1.renderer.materials;
            mats [0] = MaterialSelected;
            Body1.renderer.materials = mats;
            break;
        case 2:
            mats = Body2.renderer.materials;
            mats [0] = MaterialSelected;
            Body2.renderer.materials = mats;
            break;
        case 3:
            mats = Body3a.renderer.materials;
            mats [0] = MaterialSelected;
            Body3a.renderer.materials = mats;
            Body3b.renderer.materials = mats;
            Body3c.renderer.materials = mats;
            Body3d.renderer.materials = mats;
            Body3e.renderer.materials = mats;
            break;
        case 4:
            mats = Eyes1a.renderer.materials;
            mats [2] = MaterialSelected;
            Eyes1a.renderer.materials = mats;
            Eyes1b.renderer.materials = mats;
            break;
        case 5:
```

```
        mats = Eyes2a.renderer.materials;
        mats [1] = MaterialSelected;
        Eyes2a.renderer.materials = mats;
        Eyes2b.renderer.materials = mats;
        break;
    case 6:
        mats = Eyes3a.renderer.materials;
        mats [1] = MaterialSelected;
        Eyes3a.renderer.materials = mats;
        Eyes3b.renderer.materials = mats;
        break;
    case 7:
        mats = Foot1a.renderer.materials;
        mats [0] = MaterialSelected;
        Foot1a.renderer.materials = mats;
        Foot1b.renderer.materials = mats;
        break;
    case 8:
        mats = Foot2a.renderer.materials;
        mats [0] = MaterialSelected;
        Foot2a.renderer.materials = mats;
        Foot2b.renderer.materials = mats;
        break;
    case 9:
        mats = Foot3a.renderer.materials;
        mats [0] = MaterialSelected;
        Foot3a.renderer.materials = mats;
        Foot3b.renderer.materials = mats;
        break;
    case 10:
        mats = Hair1a.renderer.materials;
        mats [0] = MaterialSelected;
        Hair1a.renderer.materials = mats;
        Hair1b.renderer.materials = mats;
        Hair1c.renderer.materials = mats;
        break;
    case 11:
        mats = Hair2.renderer.materials;
        mats [0] = MaterialSelected;
```

```
        Hair2.renderer.materials = mats;
        break;
    case 12:
        mats = Hair3.renderer.materials;
        mats [0] = MaterialSelected;
        Hair3.renderer.materials = mats;
        break;
    case 13:

        break;
    case 14:
        mats = Ear1a.renderer.materials;
        mats [0] = MaterialSelected;
        Ear1a.renderer.materials = mats;
        Ear1b.renderer.materials = mats;
        break;
    case 15:
        mats = Ear2a.renderer.materials;
        mats [0] = MaterialSelected;
        Ear2a.renderer.materials = mats;
        Ear2b.renderer.materials = mats;
        break;
    case 16:
        mats = Ear3a.renderer.materials;
        mats [0] = MaterialSelected;
        Ear3a.renderer.materials = mats;
        Ear3b.renderer.materials = mats;
        break;
    case 17:

        break;
    case 18:
        mats = Arm1a.renderer.materials;
        mats [0] = MaterialSelected;
        Arm1a.renderer.materials = mats;
        Arm1b.renderer.materials = mats;
        Hand1a.renderer.materials = mats;
        Hand1b.renderer.materials = mats;
        break;
```

```
        case 19:
            mats = Arm2a.renderer.materials;
            mats [0] = MaterialSelected;
            Arm2a.renderer.materials = mats;
            Arm2b.renderer.materials = mats;
            break;
        case 20:

            break;
        default:

            break;
        }

}


private void OnTrackingLost()
{
  Renderer[] rendererComponents = GetComponentsInChildren<Renderer>(true);
  Collider[] colliderComponents = GetComponentsInChildren<Collider>(true);

  // Disable rendering:
  foreach (Renderer component in rendererComponents)
  {
    component.enabled = false;
  }

  // Disable colliders:
  foreach (Collider component in colliderComponents)
  {
    component.enabled = false;
  }

  Debug.Log("Trackable " + mTrackableBehaviour.TrackableName + " lost");

}
```

```
    #endregion // PRIVATE_METHODS
}
```

Script GUIBasics.cs

```
using UnityEngine;
using System.Collections;

public class GUIBasics : MonoBehaviour {
    private GameObject Body1;
    private GameObject Body2;
    private GameObject Body3;
    private Animator animator1;
    private Animator animator2;
    private Animator animator3;
    public Texture CreasixMa;
    public Texture Carrito;
    public Texture CreasixLogo;
    private bool GameEnabled;
    private GameObject fondoMenu;
    private GameObject tituloMenu;
    private GameObject logoCreasix;
    private GUIText descripcion;

    void Start (){
        GlobalVar.nGameEnabled = false;
        }

    void OnGUI () {
        Body1 = GameObject.Find ("Character1");
        Body2 = GameObject.Find ("Character2");
        Body3 = GameObject.Find ("Character3");
        CreasixMa = Resources.Load ("CreasixMa", typeof(Texture)) as Texture;
        Carrito = Resources.Load ("CarritoCompra", typeof(Texture)) as Texture;
        CreasixLogo = Resources.Load ("CreasixLogoSmall", typeof(Texture)) as Texture;
        tituloMenu = GameObject.Find ("Titulo");
        fondoMenu = GameObject.Find ("FondoMenu");
        descripcion = GUIText.FindObjectOfType<GUIText> ();
        animator1 = Body1.GetComponent<Animator> ();
```

```
animator2 = Body2.GetComponent<Animator> ();
animator3 = Body3.GetComponent<Animator> ();
if (GlobalVar.nGameEnabled) {
   fondoMenu.renderer.enabled=false;
   tituloMenu.renderer.enabled=false;
   descripcion.enabled=true;
        if (animator1.GetBool ("Parat") == false) {
            if (GUI.Button (new Rect (Screen.width-80, 10, 70, 50), "Parar")) {
               animator1.SetBool ("Parat", true);
               animator2.SetBool ("Parat", true);
               animator3.SetBool ("Parat", true);
               }
          } else {
     if (GUI.Button (new Rect (Screen.width-80, 10, 70, 50), "Girar")) {
               animator1.SetBool ("Parat", false);
               animator2.SetBool ("Parat", false);
               animator3.SetBool ("Parat", false);
               }
          }
          GUIContent content = new GUIContent();
          content.image=CreasixMa;
          content.text="Menu";
          if (GUI.Button (new Rect (10, 10, 80, 50), content)) {
             GlobalVar.nGameEnabled=false;
             fondoMenu.renderer.enabled=true;
             tituloMenu.renderer.enabled=true;
          }
   content.image=Carrito;
   content.text="Comprar";
   if (GUI.Button (new Rect (Screen.width-105, Screen.height-60, 95, 50), content)) {
      //GUARDAR VECTOR DE PARTES ACTIVADAS
      //GUARDAR VECTOR DE COLORES DE LAS PARTES
      //ABRIR CARRITO DE COMPRA
   }
   if (GUI.Button (new Rect (10, Screen.height-60, 95, 50), "Guardar")) {
      //GUARDAR VECTOR DE PARTES ACTIVADAS
      //GUARDAR VECTOR DE COLORES DE LAS PARTES
   }
     }
```

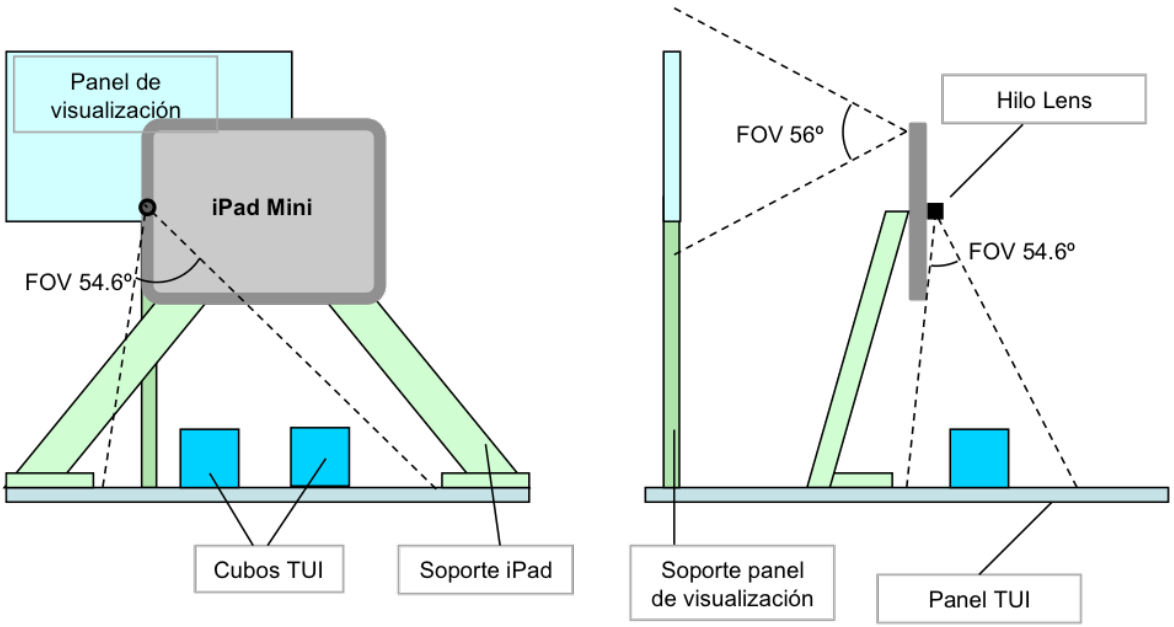
```
    else{
        descripcion.enabled=false;
        if (GUI.Button (new Rect (Screen.width/2-125, 320, 250, 70), "Crear juguete")) {
            GlobalVar.nGameEnabled=true;
            fondoMenu.renderer.enabled=false;
            tituloMenu.renderer.enabled=false;
      }
        if (GUI.Button (new Rect (Screen.width/2-125, 410, 250, 70), "Mis juguetes")) {
            //ABRIR ESCENA CON LISTADO DE JUGUETES GUARDADOS
        }
        GUIContent content = new GUIContent();
        content.image=CreasixLogo;
        content.text="  Sobre Nosotros";
        if (GUI.Button (new Rect (Screen.width/2-135, 520, 270, 70), content)) {
            //ABRIR WEBSITE DE CREASIX
        }
    }
}
}
```

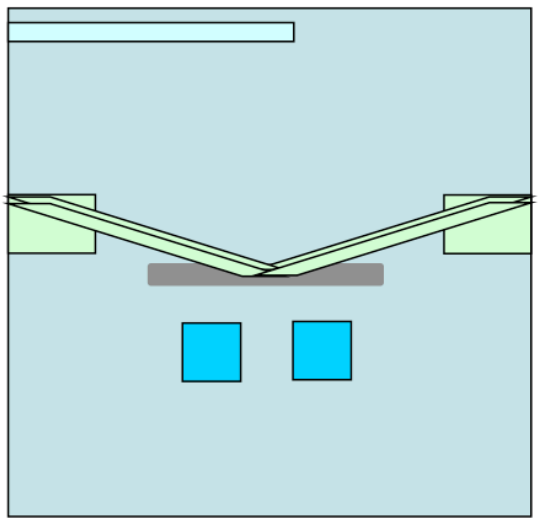
Script GlobalVar.cs

```
using UnityEngine;
using System.Collections;
    public static class GlobalVar{
    static int _globalValue;
    public static int nPartSelected
    {
      get
      {
        return _globalValue;
      }
      set
      {
        _globalValue = value;
      }}
  static  Material _globalValue2;
  public static Material MatSelected
  {
    get
    {
      return _globalValue2;
    }
    set
    {
      _globalValue2 = value;
    }}
  static bool _globalValue3;
  public static bool nGameEnabled
  {
    get
    {
      return _globalValue3;
    }
    set
    {
      _globalValue3 = value;
    }}}
```

Anexo 3: Diseño inicial del sistema de interacción

Previamente al descubrimiento del sistema Osmo, la idea era desarrollar nuestro propia sistema de interacción que combinara una *TUI* y Realidad Aumentada. Es por eso que se diseño un soporte que mantuviera el dispositivo iPad a una cierta altura para enfocar un panel de visualización, en el cual habrían marcadores para sobreponer imágenes en tiempo real del diseño del juguete mediante AR. Por otro lado, las adquiridas *HiloLens* desviarían la imagen de la cámara frontal hacia el *Panel TUI* situado en la mesa, donde mediante objetos se realizaría el modelaje de juguetes. El esquema del diseño acabó siendo el siguiente:





*La información del campo de visión (54,6º) está proporcionada por Apple.

Anexo 4: Diseño previo de fichas de juego

Realizar las 20 fichas de juego y el cubo Creasix para controlar nuestro sistema Tangible User Interface no ha sido una tarea fácil, siendo lo siguiente el *quid* de la cuestión: independentemente de la puntuación del *marker* que otorga Vuforia (la cual implica la facilidad de reconocimiento del mismo), nos hemos dado cuenta que cuando se emplea un número elevado de marcadores para una misma aplicación pueden existir frecuentes confusiones entre ellos. El motivo de este hecho es la repetición de patrones entre los diseños generados, que por muy escasa que sea ya puede causar irregularidades en el algoritmo de Vuforia.

A continuación veremos los elaborados diseños que, por mucho que fueran marcadores idóneos individualmente, generaron confusión en su reconocimiento por parte de la aplicación. Las letras y los números que los forman no sólo se repiten de vez en cuando, sino que están diseñadas bajo un mismo patrón que las divide en rectángulos con el objetivo de crear más puntos de reconocimiento.

Entendido el motivo, realizamos los 26 diseños de *targets* que constan en el trabajo, los cuales no comparten ningún patrón sino que son originarios de una base totalmente aleatoria.